

09-27-00

A

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

09/26/00

JC921 U.S. PTO
09/26/00

Attorney Docket No.: 3123-336

Inventor: David W. Chew of 7227 Emami Drive, San Jose, California 95120

Express Mail Label No.: EL617197626US

Title: "VOICE COIL FOR DISK DRIVE"

Assistant Commissioner for Patents

Box Patent Application

Washington, DC 20231

This application claims priority from U.S. Provisional Patent Application No. 60/156,411 filed September 28, 1999. The entire disclosure of the provisional application is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference. Enclosed for filing with the above-identified utility patent application, please find the following:

1. ☒ Specification (Total Pages of Text, including Abstract and Claims: 13)
2. ☒ Drawing(s) (35 USC 113) (Total Sheets: 1) ☐ FORMAL ☒ INFORMAL
3. ☒ Oath or Declaration (Total Pages: 3) ☒ Signed ☐ Unsigned
4. ☐ Microfiche Computer Program (Appendix)
5. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Attorney for applicants hereby asserts pursuant to 37 CFR § 1.821(f) that the content of the paper of computer readable copies of SEQ ID No:1 through SEQ ID No: submitted herewith are identical
6. ☒ Assignment Papers (cover sheet & document(s))
7. ☐ 37 CFR 3.73(b) Statement (when there is an assignee)
8. ☒ Power of Attorney
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure Statement (IDS/PTO-1449)
11. ☐ Copies of IDS Citations (Number of References:)
12. ☐ Preliminary Amendment
13. ☒ Return Postcard (MPEP 503) (should be specifically itemized)
14. ☐ Small Entity Statement(s)
15. ☐ Certified copy of Priority Document(s)
16. ☒ A check in the amount of \$1,074.00 is enclosed.
17. ☐ Other:

FEE CALCULATION:

	(COL. 1) NO. FILED				SMALL ENTITY			LARGE ENTITY	
					RATE	FEE		RATE	FEE
BASIC FEE:						\$345.00	OR		\$690.00
TOTAL CLAIMS:	24	-	20	4	X \$9 =		OR	X \$18 =	\$72.00
INDEP. CLAIMS:	7	-	3	4	X \$39 =		OR	X \$78 =	\$312.00
MULTIPLE DEPENDENT CLAIMS					+ \$130 =		OR	+\$260 =	\$0.00
*IF THE DIFFERENCE IN COL. 2 IS LESS THAN ZERO, ENTER "O" IN COL. 2.					TOTAL:				\$1,074 00

OTHER INFORMATION:

1. ☒ The Commissioner is hereby authorized to debit any underpayments or credit any overpayment to Deposit Account No. 19-1970.
2. ☒ The Commissioner is hereby authorized to charge all required fees for extensions of time under §1.17 to Deposit Account No. 19-1970.
3. Correspondence Address:

Todd P. Blakely, Esq.
SHERIDAN ROSS P.C.
1560 Broadway, Suite 1200
Denver, Colorado 80202-5141
Telephone: (303) 863-9700
Facsimile: (303) 863-0223

Respectfully Submitted,

SHERIDAN ROSS P.C.



Todd P. Blakely
Registration No. 31,328

Date: 9/26/2000

“VOICE COIL FOR DISK DRIVE”

RELATED APPLICATIONS

5 The present application claims priority under 35 U.S.C. § 119(e) from U.S. Provisional Patent Application Serial No. 60/156,411, filed September 28, 1999, which provisional application is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

Field Of The Invention

10 The present invention relates to disk drives for information storage in computer systems, and more particularly to a coil assembly for a voice coil motor that drives an actuator arm of the disk drive.

Description Of The Prior Art

15 Most disk drive storage systems include a plurality of disks stacked onto a rotatable spindle and a corresponding number of magnetic heads that read binary digital information from the disks and write such information on them. The magnetic heads lie mounted on sliders that an actuator arm suspends over the surfaces of the disks while the actuator arm lies rotatably mounted to a base member of the disk drive.

20 A voice coil motor drives the actuator arm; and this motor typically includes permanent magnets mounted to the base member and a wire and bobbin coil assembly mounted on the actuator arm. The forces generated by the interaction between the magnetic field of the coil assembly and those of the permanent magnets drive the actuator arm to various positions over the disks.

25 The prior art includes a large number of actuator arm assemblies with various coil and magnet arrangements. Some of these assemblies include multiple layers of wire secured to the actuator arm with adhesive and a plurality of permanent magnets disposed proximate

the wire. These constructions require complex fabrication procedures; they are susceptible to malfunction; and they do not allow easy miniaturization of the disk drive.

The coil assembly of the present invention avoids the disadvantages of the prior art constructions. It is a unique single-layer structure that optimizes force vectors and mass distribution. This construction provides a planar coil that allows easy installation onto an actuator arm, minimizing the cost of manufacture and assembly and enhancing miniaturization of the drive. It is a simple construction that provides consistent and efficient performance.

SUMMARY OF THE INVENTION

In accordance with one embodiment of this invention, a voice coil for a disk drive includes a spiral formation of winding of an electrically conductive material. This formation has a generally triangular shape with an open center. First and second active leg portions of the formation curve inward of it, and an inactive leg portion curves outward of it. The cross-sectional area of the coil varies along its length with the segments in the inactive leg portion having a smaller cross-sectional area than those of the remaining active segments. The voice coil is a laminate with the conductive layer disposed between two electrically insulating layers. It lies fixedly secured to a surface of the actuator arm. The method of making this laminate includes securing the conductive layer to an insulating layer, removing selected portions of the conductive layer to form the coil, and covering the conductive layer with another insulating layer.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of this invention, one should now refer to the embodiment illustrated in greater detail in the accompanying drawings and described below by way of an example of the invention. In the drawings:

FIG. 1 is a perspective view of a disk drive that includes the voice coil of the present invention;

FIG. 2 is a sectional view taken along line 2-2 in FIG. 1;

FIG. 3 is a sectional view taken along line 3-3 in FIG. 2; and

FIG. 4 is a sectional view taken along line 4-4 in FIG. 2.

While the following disclosure describes the invention in connection with one embodiment, one should understand that the invention is not limited to this embodiment. Furthermore, one should understand that the drawings are not to scale and that graphic symbols, diagrammatic representatives, and fragmentary views, in part, may illustrate the embodiment. In certain instances, the disclosure may not include details which are not necessary for an understanding of the present invention such as conventional details of fabrication and assembly.

DETAILED DESCRIPTION OF THE DRAWINGS

Turning now to the drawings and referring specifically to FIG. 1, a disk drive apparatus A includes an actuator 10 with an arm 11 which supports the voice coil assembly 12 of the present invention and a pivot assembly (not shown) which pivotally connects the actuator 10 to a base B of the apparatus A. Permanent magnets (not shown) disposed on the base B provide a magnetic field that interacts with the magnetic field provided by the voice coil assembly 12 to drive the actuator to various positions over a disk D of the disk drive apparatus A.

The actuator 10 of this disk drive apparatus A is a planar structure suited for use in a single disk system. However, the voice coil assembly of the present invention 10 may alternatively operate in other actuator constructions, including those used in multi-disk systems. The arm or base 11 of the actuator 10 is a flat plate-like member made out of aluminum, non-magnetic steel, or any other suitable material.

The voice coil assembly 12 is a laminate structure with a bottom, electrically insulating layer 14, a middle, electrically conductive layer 15, and a top, electrically insulating layer 16. The bottom and top layers may be polyimide or any other suitable material while the middle layer may be copper or other conductive material. A laminating adhesive secures one layer to another layer as well as the bottom layer to the actuator base 11.

09670661-09660000

The conductive layer 15 is a single, spiraling trace that forms a generally triangular band 17 with an open center, first and second active legs, 15a and 15b, an inactive leg 15c, a first curved corner portion 15d connecting the first and second active leg portions, a second curved corner portion 15e connecting the first active leg portion with the inactive leg portion, and a third curved corner portion 15f connecting the second active leg portion with the inactive leg portion. The first and second active leg portions, 15a and 15b, curve inwardly of the band while the inactive leg portion 15c curves outwardly of it. (Also, although not necessary, the average radius of curvature of the first curved corner portion is greater than the average radius of curvature of the second and third corner portions; and the average radius of curvatures of the second and third corner portions is substantially the same.)

As shown in FIG. 2, the first and second leg portions of the band 17 each have a predetermined width W' while the third leg portion has a width W which is smaller in magnitude than the width of the first and second leg portions. While the spacing between each loop of the trace 17 remains substantially the same throughout the trace, as does the height of the trace, the width varies, with the segments defining the third leg portion being substantially smaller than the segments defining the first and second leg portions (See FIGS. 3 and 4).

The pivot axis of the actuator lies outwardly of the coil 12 proximate the first curved corner portion 15d. Since the third, inactive leg portion lies the furthest of the three legs from the pivot axis, it makes a substantial contribution to actuator inertia. However, it does not provide any torque in the desired direction of rotation of the actuator because it directs the force that it generates towards the actuator pivot. A reduction in the trace width (or cross-sectional area) in the third leg portion results in a reduction in mass and inertia. However, the reduction in the width is not of a magnitude that would cause a significant increase in the resistance in this portion of the trace.

As described above, the first and second leg portions curve inwardly of the trace 17. This “concave” configuration aligns the electromotive force vector better than straight or convex legs. This configuration provides a higher torque constant (K_t) than does the configuration of a conventional coil with a similar size.

The method of making the voice coil assembly of the present invention 12 includes the following steps: securing a sheet of material (e.g., copper) that comprises the middle layer 15 to the bottom layer 16 (as with adhesive), removing (as with photo-etching) portions of the middle layer to form a single trace of varying cross-sectional area, and securing (as
5 with adhesive) the third layer 16 to cover the trace 17. The next step in this process includes securing (e.g., with adhesive) the bottom layer 14 to the arm 11.

By way of a specific example for a 3.5 inch disk drive form factor,, a voice coil of the present invention was constructed with a bottom polyimide layer having a height of 1 mil, a middle copper layer of 1.5 mil and top polyimide layer of 1 mil. The maximum width T_1
10 for the trace in the first and second leg portions was 5 mil with a maximum spacing S between adjacent loops of 3 mil (See FIG. 3). The maximum width T_2 for the trace in the third, inactive leg portion was 3 mil with a maximum spacing S between adjacent segments of 3 mil (See FIG. 4).

While the above description and the drawings disclose and illustrate one embodiment,
15 one should understand, of course, that the invention is not limited to this embodiment. Those skilled in the art to which the invention pertains may make other modifications and other embodiments employing the principles of this invention, particularly upon considering the foregoing teachings. Therefore, by the appended claims, the applicant intends to cover any modifications and other embodiments as incorporate those features which constitute the
20 essential features of this invention.

What is claimed is:

1. A voice coil for a disk drive comprising: a spiral winding of conductive material defining a flat band with a generally triangular shape having an open center, first and second active leg portions and an inactive leg portion, a first curved corner portion connecting the first and second active leg portions, a second curved corner portion connecting the first active leg portion with the inactive leg portion, and a third curved corner portion connecting the second leg portion with the inactive leg portion, the first and second active leg portions curving inward of the band, the inactive leg portion curving outward of the band.
- 5 2. The coil of claim 1, wherein the radius of curvature of the first curved corner portion is greater than the radius of curvature of the second and third curved corner portions.
3. The coil of claim 2, wherein the radius of curvature of the second curved corner portion is equal to the radius of curvature of the third curved corner portion.
4. The coil of claim 1, wherein the cross-sectional area of the band varies along the length of the spiral winding.
5. The coil of claim 4, wherein the cross-sectional area of the segments that define the inactive leg portion is smaller than the cross-sectional area of the remaining segments.

5 6. A voice coil for a disk drive comprising: a spiral winding of conductive material defining a flat band with a generally triangular shape with an open center, first and second active leg portions and an inactive leg portion, a first curved corner portion connecting the first and second active leg portions, a second curved corner portion connecting the first active leg portion with the inactive leg portion, and a third curved corner portion connecting the second leg portion with the inactive leg portion, the cross-sectional area of the band varying along its length.

7. The coil of claim 6, wherein the cross-sectional area of each of the segments that define the inactive leg portion is smaller than the cross-sectional area of each of the remaining segments.

5

11. In combination with an actuator member in a disk drive, a voice coil secured to a face of the actuator member, said voice coil comprising a continuous spiral winding defining a flat band with a generally triangular shape with an open center, first and second active leg portions and an inactive leg portion, a first curved corner portion connecting the first and second active leg portions, a second curved corner portion connecting the first active leg portion with the inactive leg portion, and a third curved corner portion connecting the second leg portion with the inactive leg portion, the first and second active leg portions curving inward of the band, the inactive leg portion curving outward of the band.

12. The coil of claim 11, wherein the radius of curvature of the first curved corner portion is greater than the radius of curvature of the second and third curved corner portions.

13. The coil of claim 12, wherein the radius of curvature of the second curved corner portion is equal to the radius of curvature of the third curved corner portion.

14. The coil of claim 11, wherein the cross-sectional area of the band varies along its length.

15. The coil of claim 14, wherein the cross-sectional area of the segments that define the inactive leg portion is smaller than the cross-sectional area of the remaining segments.

16. In combination with an actuator member in a disk drive, a voice coil secured to a face of the actuator member, said voice coil comprising a continuous spiral winding of wire defining a flat band with a generally triangular shape with an open center, first and second active leg portions and an inactive leg portion, a first curved corner portion connecting the first and second active leg portions, a second curved corner portion connecting the first active leg portion with the inactive leg portion, and a third curved corner portion connecting the second leg portion with the inactive leg portion, the cross-sectional area of the band varying along its length.

17. The coil of claim 16, wherein the cross-sectional area of the segments that define the inactive leg portion is smaller than the cross-sectional area of the remaining segments.

18. The first and second active leg portions curving inward of the band, the inactive leg portion curving outward of the band.

19. The coil of claim 16, wherein the radius of curvature of the first curved corner portion is greater than the radius of curvature of the second and third curved corner portions.

20. The coil of claim 19, wherein the radius of curvature of the second curved corner portion is equal to the radius of curvature of the third curved corner portion.

5 21. A method of making a voice coil for a disk drive actuator, said method comprising the steps of providing a first, electrically insulating layer of material of a predetermined thickness; securing a second, electrically conductive layer of material onto the first layer; removing a predetermined portion of the second layer to form a planar, electrically conductive coil; securing a third electrically insulating layer of material to the second layer to form a coil laminate; securing the laminate to the actuator.

22. The method of claim 21, further comprising the step of providing adhesive to secure the first, second and third layers together.

23. The method of claims 22, wherein the first and third layers are polyimide and the second layer is copper.

24. The method of claim 21, wherein the step of removing a predetermined portion of the second layer includes photo-etching.

ABSTRACT

A voice coil for a disk drive includes a spiral formation of winding of an electrically conductive material. This formation has a generally triangular shape with an open center. First and second active leg portions of the formation curve inward of it, and an inactive leg portion curves outward of it. The cross-sectional area of the coil varies along its length with the segments in the inactive leg portion having a smaller cross-sectional area than those of the remaining segments. The voice coil is a laminate with the conductive layer disposed between two electrically insulating layers. It lies fixedly secured to a surface of a base member of the disk drive's actuator. The method of making this laminate includes securing the conductive layer to an insulating layer, removing selected portions of the conductive layer to form the coil, and covering the conductive layer with another insulating layer.

FIG. 1

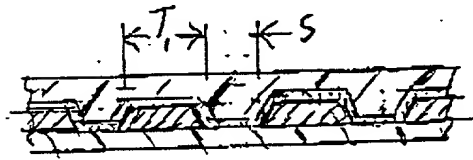
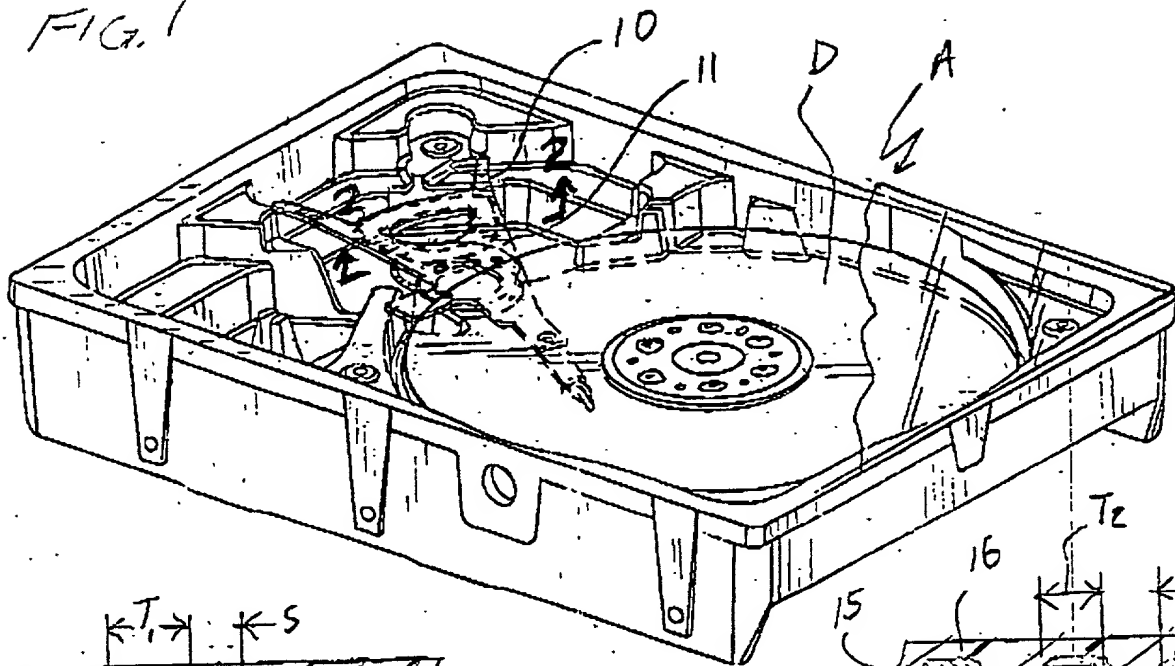


FIG. 3

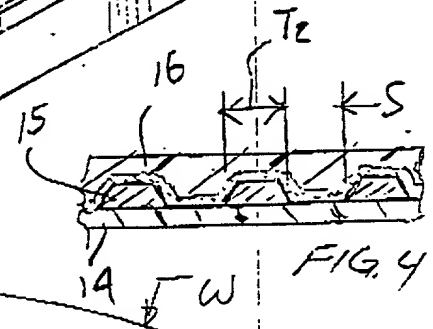


FIG. 4

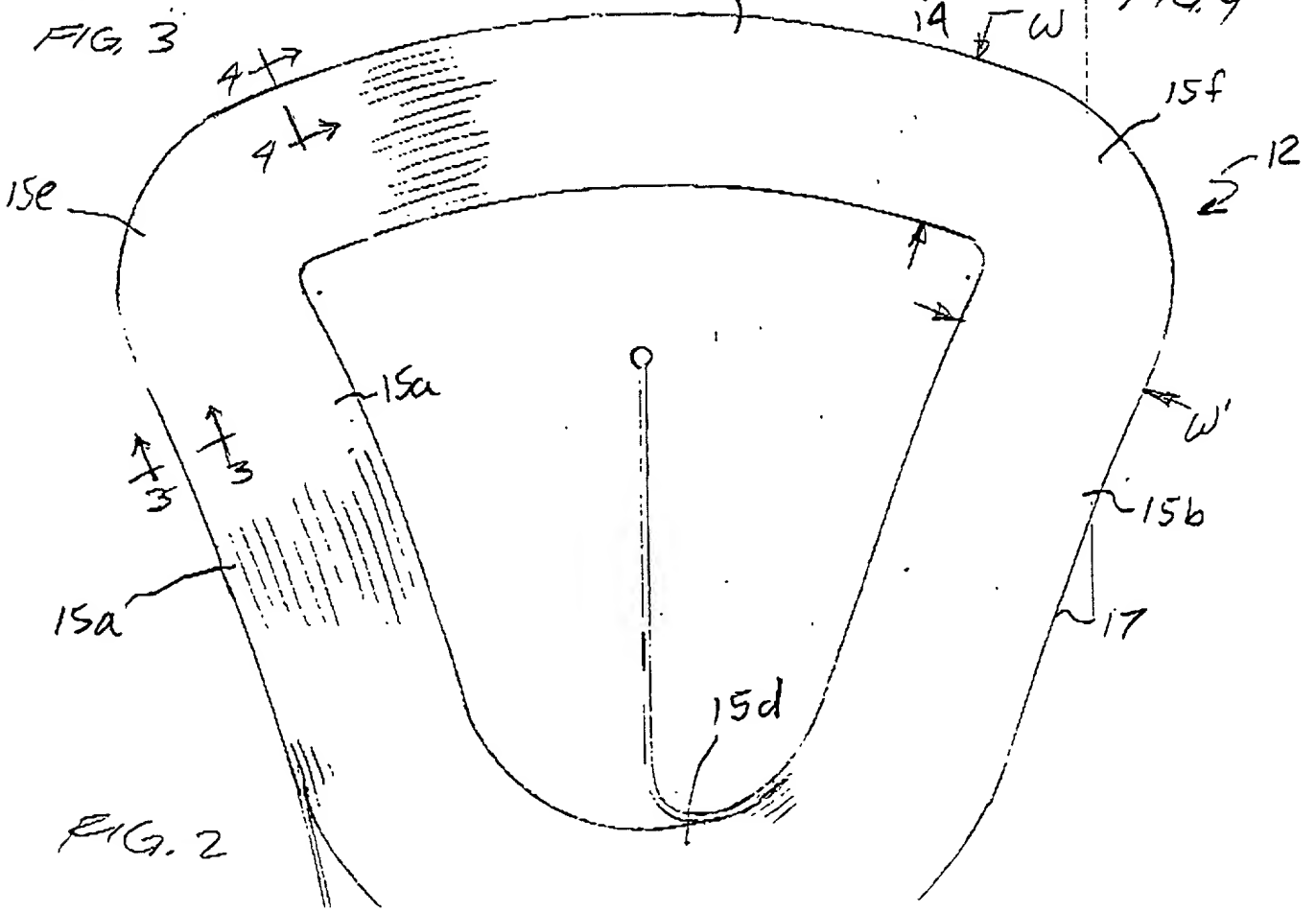


FIG. 2

00570641.093600

RULE 63 (37 CFR 1.63)
DECLARATION
FOR PATENT APPLICATION
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe that, I am an original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled "VOICE COIL FOR DISK DRIVE", the specification of which is identified as Attorney File No. 3123-336.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability in accordance with 37 CFR 1.56(a) and (b) as set forth on the attached sheet indicated Page 3 hereof and which I have read.

I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
<u>Number</u>	<u>Country</u>	<u>Day/Month/Year Filed</u>	<u>Yes</u>	<u>No</u>
None				

I hereby claim the benefit under 35 U.S.C. 119(e)/120/365 of all United States and PCT international applications, including all United States provisional applications, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior applications in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information material to patentability in accordance with 37 CFR 1.56(a) and (b) which occurred between the filing date(s) of the prior application(s) and the national or PCT international filing date of this application:

<u>Application Serial No.</u>	<u>Filing Date</u>	<u>Status: patented, pending, abandoned</u>
60/156,411	September 28, 1999	Pending

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1) Inventor's Signature David W. Chew Date 9/25/00

Inventor's Name (typed): David W. Chew

Citizenship: U.S.A.

Residence: 7227 Emami Drive
San Jose, California 95120

Post Office Address*: Same as Residence

*Complete Post Office Address in full if different from Residence, otherwise indicate that the Post Office Address is "Same as Residence."

37 CFR §1.56(a) and (b)
DUTY TO DISCLOSE INFORMATION MATERIAL
TO PATENTABILITY

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application,

and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of a patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.*

*Note, 37 CFR §1.97(h) states: "The filing of an information disclosure statement shall not be construed to be an admission that the information cited in the statement is, or is considered to be, material to patentability as defined in §1.56(b)."

GENERAL POWER OF ATTORNEY

On behalf of Maxtor Corporation, a Delaware corporation having a principal place of business at 2190 Miller Drive, Longmont, Colorado 80501, I, Carlotta Barr-Smith, Assistant Secretary of Maxtor Corporation, hereby appoint:

David M. Sigmond of Maxtor Corporation, Registration No. 34,013; and

David F. Zinger, Registration No. 29,127; Craig C. Groseth, Registration No. 31,713; Michael L. Tompkins, Registration No. 30,980; Sabrina C. Stavish, Registration No. 33,374; Todd P. Blakely, Registration No. 31,328; Lewis D. Hansen, Registration No. 35,536; Joseph E. Kovarik, Registration No. 33,005; Gary J. Connell, Registration No. 32,020; Wannell M. Crook, Registration No. 31,071; Douglas W. Swartz, Registration No. 37,739; Bruce A. Kugler, Registration No. 38,942; Robert R. Brunelli, Registration No. 39,617; Richard L. Hughes, Registration No. 31,264; Tejpal S. Hansra, Registration No. 38,172; Dana L. Hartje Cardwell, Registration No. 40,638, Angela Dallas-Pedretti, Registration No. 42,460; Benjamin B. Lieb, Registration No. 42,801; Bradley M. Knepper, Registration No. 44,189; Theresa A. Brown, Registration No. 32,547; and Miriam R. Drickman Trudell, Registration No. 42,499, of SHERIDAN ROSS P.C., 1560 Broadway, Suite 1200, Denver, Colorado 80202-5141, telephone number 303/863-9700, as attorneys and agents for MAXTOR CORPORATION before the U.S. Patent Office, any foreign patent offices and all competent International Authorities in connection with any and all U.S., foreign and international patent applications filed on behalf of MAXTOR CORPORATION, with full powers of substitution, association and revocation, and to transact all business in the U.S. Patent and Trademark Office and all foreign and international patent offices connected therewith.

Date:

10 July 2000

By:

C. Barr-Smith

Carlotta Barr-Smith

Assistant Secretary of Maxtor Corporation